

# PATENT SPECIFICATION

DRAWINGS ATTACHED

980.558

980.558



Date of Application and filing Complete Specification July 13, 1962.

No. 27119/62.

Application made in Germany (No. S 74927 VIIIc/21g) on July 21, 1961.

Complete Specification Published Jan. 13 1965.

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Index at acceptance: —H1 K(1A1, 1CX, 2S1, 2S2, 2S11, 4C, 4F1, 4F2, 4F7, 4F11, 4FX, 5)

Int. Cl.:—H 01 1

## COMPLETE SPECIFICATION

### A Semi-conductor Device

We, SIEMENS-SCHUCKERTWERKE AKTIEN-GESELLSCHAFT, a German Company of Berlin and Erlangen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a semiconductor device.

Investigations and considerations have shown that a desired good electric and thermal transfer between the semi-conductor element and the corresponding housing part of a semi-conductor device for carrying the current and dissipating the Joule heat produced at the semi-conductor rectifier element can be achieved by ensuring a good mutual contact between the semi-conductor rectifier element and the corresponding housing part at their contacting faces during operation of the device. The connection between these faces is usually made by a soldered joint but this joint is subjected to repeated thermal stresses which occur between the various parts during the operation of the semi-conductor device. Stresses occur as a result of different thermal expansion of the parts adjacent one another at the joint, during any change in temperature of the device.

According to the present invention there is provided a semi-conductor device comprising a housing enclosing a semi-conductor element which has two main opposite faces, wherein one of the two main faces of the semiconductor element is connected electrically to one portion of the housing, and the other main face of the semiconductor element is connected electrically to one end of a rigid conductor which leads to an outer connection part of the device, the connections of the said one portion of the housing and the said one end of the rigid conductor to the respective main faces of the semiconductor element

being pressure connection only, and the pressure being provided by spring means which do not form part of an electrically conducting path through the device *via* the semiconductor element.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made to the accompanying drawing, which shows a partial-sectional side view of an assembled rectifier device.

In the drawing a base plate 1 has hard-soldered thereto an iron ring 2 which can be easily welded. The base plate 1 has a central bearing pedestal portion 3, on which there is slidably mounted an auxiliary molybdenum carrier plate 4 with the interposition therebetween of a silver layer 5. The plate 4 may instead consist of tantalum or tungsten, and the intermediate layer 5 may consist of any suitable ductile metal. A semi-conductor body 7 has an alloyed-in electrode 6 of aluminium on its lower face and an alloyed-in electrode 8 of gold-containing-antimony on its upper face. The carrier plate 4 is shown alloyed to the electrode 6, so that the semi-conductor body, its electrodes and the carrier plate 4 form a semi-conductor element. A rigid connecting pin 9, the lower part of which has a larger cross-sectional area than the stem part thereof, is provided on the lower face thereof with a plate 9a which is similar to the plate 4, and which is hard-soldered or welded to the pin 9. The lower surface of the plate 9a is slidably mounted on the electrode 8 with the interposition of an intermediate silver layer 8a between the plate 9a and the electrode 8. The contacting surfaces between parts 3, 4 and 5, and between parts 8, 8a and 9 may be prepared by a grinding operation or the like to match these surfaces. The ductile metal layers 5 and 8a may be dispensed with if required. A bell-like housing 10 consists of a cylindrical metal body 11, an

[Price 4s. 6d.]

insulating body 12, for example of glass, and an inner metal sleeve-like body 13. The parts 11 to 13 together form a so-called pressure-glass seal. Introduced into and hard-soldered on the upper end of the inner sleeve 13 is a sleeve-like body 14, which has in its upper part thereof a cup-shaped contact spring member 15. The other end of the conductor 9 is seated in the spring member 15. Alternatively, an electrically conductive connection between the sleeve-like body 14 and the rigid conductor 9 can be made by pressing fast the sleeve-like body on or into the surrounding surface of the rigid conductor.

Disposed on the upper face of the lower part of the conductor 9 within the housing is a pressure plate 17 on which is a disc 18 of electrically insulating material, and on this disc 18 is a pressure ring 19. Stacked on the ring 19 are a number of springs 20 to 22 which are bell-shaped or dished and which bear one another at their outer and inner extremities. As can be seen the stack of springs 20 to 22 bears against the ring 19 and against a ring-shaped ledge 23 in cup-shaped metal body 24 which is within the body 11. If the body 24 consists of electrically insulating material, for example ceramic, then the insulating disc 18 may be omitted. This cup-shaped body 24 is provided with a step 25 near its lower end, so that part of the body 24 bears against the pedestal body 3 and is guided thereby, and the step 25 bears against part of the upper surface of the auxiliary carrier plate 4 against which it is urged by springs 27 to 30 to help to provide the pressure connection between parts 3 and 4. The dished or bell-shaped springs 27 to 30 are combined in pairs and form a stack, one end of which bears against the upper end face of the body 24 and the other of which bears against a ring-shaped recess 31 in the inner surface of the body 11. The whole assembly is mechanically held together by the bell-shaped portion 11 being butt-connected at its lower edge to the body 2, for example by electric resistance welding.

The connection between the parts 3 and 4 and between 8 and 9a are formed as pressure connections to obviate the need for soldered connections and thus to do away with those stresses which arise in such soldered joints as a result of the Joule heat produced by the device when it is in operation. The pressure causing the contact between the various parts is transmitted through the two sets of springs 20 to 22 and 27 to 30 which are kept under compression by the parts 23 and 31 respectively. The external housing of the device can be provided with an insulating duct through which can extend electrical conductors from the terminal connecting points of the internal components of the device.

The two sets of springs 20 to 22 and 27 to 30 could be replaced by just a single set of springs. The two sets, however, are to be preferred because a more reliable and constant pressing force is obtained. The springs 27 to 30 can be made stronger than springs 20 to 22, and by a suitable adjustment of the strength of these springs and the various areas of contact, substantially the same pressure per unit area can be produced between the semi-conductor body 7 and the auxiliary carrier plate 4 as between the plate 4 and the pedestal portion 3.

The mechanical interconnection of the housing parts of the arrangement may take place in various ways, for example by soldering or welding. One or more conductors extending from the pole of the enclosed semi-conductor element may be constructed either as rigid or flexible conductors, one of which may enclose the other, and which may extend into one or more sleeve-like bodies assisting in forming an electrically insulating bushing, and which may be slidable on corresponding contact springs in the said body or bodies, or they may be firmly clamped in the latter. However, such a connecting conductor may, especially if it is of flexible nature, be secured in a sleeve-like body by a pressing action, if desired when the conductor portion on which the pressing takes place has previously been covered by a sleeve-like body. The mechanical connection may either be made purely by a pressing action, or it may be, for example, additionally welded.

#### WHAT WE CLAIM IS:—

1. A semiconductor device comprising a housing enclosing a semiconductor element which has two main opposite faces, and wherein one of the two main faces of the semiconductor element is connected electrically to one portion of the housing, and the other main face of the semiconductor element is connected electrically to one end of a rigid conductor which leads to an outer connection part of the device, the connections of the said one portion of the housing and the said one end of the rigid conductor to the respective main faces of the semiconductor element being pressure connections only, and the pressure being provided by spring means which do not form part of an electrically conducting path through the device *via* the semiconductor element.

2. A device according to claim 1, wherein at least one of the two pressure connection arrangements is such that a sliding movement is possible between the pertinent main face of the semiconductor element and the member to which it is connected.

3. A device according to claim 1 or 2, wherein one or each of the said connections takes the form of direct physical contact as between the pertinent main face of the semi-

conductor element and the member to which it is connected.

4. A device according to any preceding claim, wherein the semiconductor element includes an auxiliary carrier plate, one face of which constitutes the said one of the two main faces of the semiconductor element, the said spring means includes a first spring arrangement which acts on the other main face of the semiconductor element, and wherein the spring force acting on the element is determined by the disposition of an inner hollow body which is surrounded by the said housing and itself surrounds the semiconductor element and which is subjected to the action of a second spring arrangement acting as between the inner hollow body and part of the said housing, which latter part of the housing is mechanically connected to the said one portion of the housing, and wherein the auxiliary carrier plate is pressed against the said one portion of the housing by the said inner hollow body.

5. A device according to any preceding claim, wherein the said rigid conductor extends into a sleeve-like body which constitutes the said outer connection part and which is connected to an inner metal body which extends through an insulating bushing comprising one housing part, and wherein the said rigid conductor is electrically conductively connected to the sleeve-like body.

6. A device according to claim 5, wherein

the electrically conductive connection between the sleeve-like body and the rigid conductor is made by pressing fast the sleeve-like body on or into the surrounding surface of the rigid conductor. 35

7. A device according to claim 5 or 6, wherein the sleeve-like body comprises on its inner surface a spring contact system into which the said rigid conductor is introduced in the manner of a connector pin into a connector socket to provide the electrically conductive connection between the sleeve-like body and the rigid conductor. 40 45

8. A device according to any one of claims 1, 2 and 4 to 7, except when read as appendant to claim 3, wherein a ductile interlayer is employed between one or each of the two pairs of surfaces which are connected by respective pressure connections only. 50

9. A device according to any preceding claim, wherein one or each of the two pairs of faces which are connected by respective pressure connections only have been ground or mated by a grinding operation. 55

10. A semi-conductor device, substantially as hereinbefore described with reference to the accompanying drawing. 60

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COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of  
the Original on a reduced scale*

